Income Inequality, Banking Competition, and Monetary Policy

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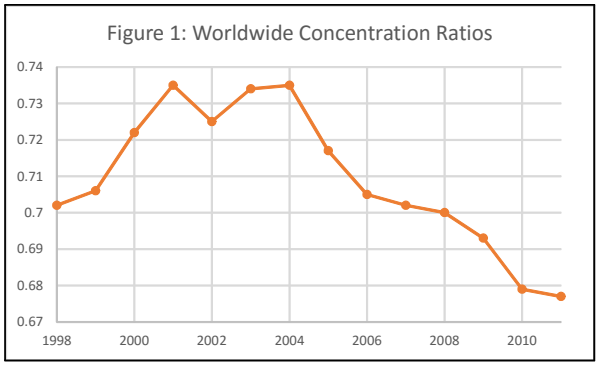
Abstract

In recent years, there has been increased attention drawn to the degree of concentration in the banking sector in advanced countries. In addition, we present evidence that there have been divergent trends in the degree of concentration across the global banking system. This is likely to be significant in low income countries which tend to have more income inequality. Moreover, such countries also generally exhibit high rates of money growth which may reinforce distortions from banking concentration. Therefore, we ask whether the concentration of assets across banking systems will impact the concentration of income across different populations. To that end, we develop a monetary growth production model with heterogeneous agents. Notably, the model shows that greater concentration of the banking system can lead to higher income inequality. The twin distortions from concentration and high rates of money growth also contribute to inequality. Regression results from cross-country data are consistent with the predictions of the model.

1 Introduction

Since the global financial crisis erupted, there has been much concern about the degree of concentration among large-scale financial intermediaries in advanced countries. Consequently, the term "Too Big to Fail" is often used to reflect the size of such institutions. However, the recent consolidation in the United States was not an isolated occurrence. Rather, it is part of a trend that has taken place over a number of years. For example, in the United States, there were around 19,000 different banks in 1989. After ten years, the number was down to one-half. Moreover, Janicki and Prescott (2006) recently found that around 75% of assets in the U.S. banking system are held by less than 1% of firms.

Prior to the crisis, it appeared that the global banking system was headed down the same path as the United States. To see this, please refer to Figure 1 which presents the average 3-firm concentration ratio in the banking systems



across around 125 different countries.[1] That is, it looked like increasing concentration would be a global phenomenon occurring in *both* advanced and developing countries. In stark contrast, in recent years, the global trend has changed.

The changes in concentration of financial intermediaries in developing countries are particularly interesting as it is well understood that income inequality can be much higher in poor countries than advanced countries. In addition, it is also understood that the degree of concentration varies considerably across countries. For example, Kashyap and Stein (1997) and Cechetti (1999) discuss the significant differences in concentration across countries in the European Monetary Union.[2]

Consequently, one must ask "Will the concentration of assets across banking systems affect the concentration of income across populations?" To this date, there has not been any work that has addressed this critical question.

However, in recent years, there has been growing interest in understanding the redistributive consequences from inflation across countries. In particular, Albanesi (2007) provides cross-country observations to demonstrate that inflation is positively correlated with income inequality. In addition, Easterly and Fisher (2001) observe that the poor are more likely than the rich to be worried about inflation across nearly 40 different countries. Given the recent patterns of consolidation, would the adverse effects of inflation on income inequality in poor countries be even more severe under higher degrees of concentration in the banking system?

The objective of this paper is to examine these important issues. To do so, we construct a monetary growth model with heterogenous agents: capital owners and individuals who hold liquid assets. In order to account for the different degrees of market power among banks in the financial system, a model must first address the important economic functions of financial intermediaries. Second, one must consider a framework with imperfectly competitive institutions who

[1] World Bank Global Development dataset, Source Code: GFDD.01.01. The concentration ratio represents assets of the three largest commercial banks as a share of total commercial banking assets in the economy in a given year. Concentration ratios are reported for countries and years in which there is also available data on capital formation, GDP-Growth, and M1-growth.

[2] See also Ghossoub et al. (2012) and Ghossoub and Reed (2015).

engage in strategic behavior so that the level of real activity depends on the industrial organization of the banking system. Finally, in order to understand the implications of money growth in conjunction with the concentration of the banking sector, the model should include a well-defined transactions role for money.

Our model includes all three features. First, building on Diamond and Dybvig (1983), banks provide risk-pooling functions to depositors in order to help shield them from liquidity risk. Second, intermediaries engage in Cournot competition in factor markets. Consequently, banks exploit their market power by holding back resources available to firms. That is, in contrast to Bencivenga and Smith (1991), banks in concentrated sectors will not provide the same functions that promote investment as under perfect competition. As a result, the industrial organization of the banking system affects capital accumulation, risk-sharing, and income inequality across the population. Finally, following Schreft and Smith (1997, 1998), money provides a well-defined transactions role due to frictions from limited communication and restrictions on asset portability.

We now address the previous questions that were raised. To begin, would greater concentration of the banking system lead to more income inequality? Our theoretical work indicates it would. Imperfectly competitive institutions will act strategically in capital markets and take into account that they face downward-sloping demand curves – greater concentration will reinforce these incentives. Thus, capital owners would receive high rates of return while wages would be lower.

Next, will the impact of inflation on income inequality be stronger if the banking sector is more concentrated? Unfortunately, yes. Higher rates of money growth lower the purchasing power of money and would leave individuals susceptible to liquidity shocks with less real income and consumption. Under perfect competition, banks would acquire more money balances to protect risk-averse depositors from the liquidity shock. However, among imperfectly competitive institutions, there are strategic considerations at work. In order to take advantage of their market power in the capital market, banks would already have excessively large holdings of money balances. Thus, the desire among concentrated banks to acquire more money balances would be weaker. In turn, the twin distortions – money growth and strategic behavior in capital markets – produce even more income inequality.

Finally, we examine whether there is empirical support for the predictions obtained from our modeling framework. To do so, we examine cross-country data on income inequality provided by the World Bank. First, as predicted by the model, capital accumulation is weaker in more concentrated banking systems. Second, we turn to the implications for inequality. Regression analysis does indicate that greater concentration is positively correlated with higher income inequality. And, as indicated by the model, the adverse effects of money growth on income inequality are indeed stronger at higher degrees of concentration. Consequently, changes in the concentration of the global banking system will have a significant impact on the aggregate level of income along with the distribution of income.

There are two strands of the recent literature which are related to our contribution. The first examines the implications of financial development for income inequality. For example, Greenwood and Jovanovic (1990) develop a model to show that financial development can lead to higher income inequality. If one were to interpret increased concentration of the banking system as a consequence of financial development, our analysis would be consistent with their conclusions. On the other hand, Ghossoub and Reed (2015) develop a framework which shows that income inequality may be lower as the financial system progresses as long as inflation is low. However, in contrast to our work, they assume that the banking sector is perfectly competitive.

Consequently, there have been recent developments in a separate line of work aimed at understanding the impact of the industrial organization of the banking system for real activity. To begin, Boyd, DeNicolo and Smith (2004) construct a theoretical model to study how competition affects the probability of a liquidity crisis in the banking system. It is also well understood that the transmission channels of monetary policy depend on how policy affects the incentives of institutions in the banking system. To that end, Ghossoub et al. (2012) show that the qualitative effects of money growth critically hinge on the competitive structure of the banking system. Under perfect competition, higher rates of money growth lead to a Tobin asset substitution channel whereby money growth promotes credit activity. In stark contrast, the opposite occurs in a monopolistic sector.[3] Matsuoka (2011) extends their framework to study optimal monetary policy across the competitive structure of the banking sector. More recently, Ghossoub and Reed (2015) put forward a model with a size distribution of banks to show that the efficacy of monetary policy is weaker if the banking system is dominated by a small number of large institutions. Nevertheless, none of these papers examine the consequences of monetary policy across the distribution of income in settings with heterogeneous agents as we do.

The paper is organized as follows. Section 2 describes the economic environment set out as part of the modeling framework. Section 3 looks at trade in factor markets while Section 4 extends the analysis to consider banking sector activity and steady-state general equilibrium outcomes. Section 5 uses the framework to conduct welfare analysis. Section 6 presents the empirical work that sets out to test the primary theoretical predictions from the model. Finally, section 7 concludes.

[3] By comparison, Ghossoub and Reed (2010) construct a framework in which the incidence of liquidity risk and the transactions role for money depends on the level of economic development. In particular, they posit that individuals in countries at lower levels of economic development will be more susceptible to liquidity risk. Interestingly, despite the assumption of a perfectly competitive banking sector, they find that the effects of money growth depend on the stage of economic development. In poor countries, a reverse-Tobin effect occurs while in advanced countries money growth promotes economic activity. Consequently, their analysis is consistent with recent empirical contributions that indicate that the effects of money growth differ in systematic ways across countries.

2 Environment

Consider a two-period overlapping generations economy in discrete time where $t = 1, 2, .., \infty$. The economy is divided into two geographically separated, yet symmetric locations or islands. At the beginning of each period, a unit mass of consumers are born on each island. An exogenous fraction, ρ, of these individuals are entrepreneurs (borrowers) and the remaining $(1 - \rho)$ are potential depositors (lenders). In addition to entrepreneurs and depositors, N bankers are born on each island. Each bank is indexed by j where $j = 1, 2, ..., N$.

Both entrepreneurs and depositors are born with one unit of labor effort which they supply inelastically when young and are retired when old. On the other hand, bankers do not have any endowments. Moreover, all agents care only about their old age consumption of the single perishable good, c_{t+1}. The preferences of a typical entrepreneur and a depositor are given by $u(c_{t+1}) = \frac{c_{t+1}^{1-\theta}}{1-\theta}$, where $\theta > 1$ is the coefficient of risk aversion. However, bankers are risk-neutral.

The consumption good is produced by old entrepreneurs. In particular, each entrepreneur has access to a Cobb-Douglas production technology that uses labor and capital to produce final output. The production function operated by an old entrepreneur is expressed as $y_t = f(k_t, l_t) = Ak_t^{\alpha} l_t^{1-\alpha}$, where k_t and l_t are the amounts of capital and labor used by *each* entrepreneur in period t. The parameter A represents total factor productivity and $\alpha \epsilon (0, 1)$ reflects capital intensity. Further, let K_t and L_t denote the aggregate stocks of capital and labor on each island. The capital stock completely depreciates during the production process.

There are two assets in this economy: physical capital and money (fiat currency). One unit of goods invested by a young entrepreneur in period t becomes one unit of capital at the beginning of the following period. Define i_t to be the amount of goods invested in physical capital by a typical entrepreneur in period t. As we discuss below, we will focus on economic conditions in which entrepreneurs would seek to obtain additional resources for production. That is, entrepreneurs will seek external financing from banks.

M_t is the aggregate nominal monetary base at time t. At the initial date, the stock of capital (K_0) is in the hands of old entrepreneurs. In addition, the initial stock of money (M_0) is in the hands of old depositors. Assuming that the price level is common across locations, we refer to P_t as the number of units of currency per unit of goods at time t.

As in previous studies such as Schreft and Smith (1997, 1998), there is private information and limited communication between islands. These trade frictions are overcome by using fiat money if an agent is relocated to a different location. Moreover, depositors in the economy are subject to relocation shocks. That is, after portfolio allocations are made, a fraction $\pi \in (0, 1)$ of such agents is randomly chosen to relocate. The probability of relocation on each island is the same and is known by all agents.

Unlike depositors, entrepreneurs and bankers are not subject to relocation

shocks. Moreover, as in Diamond and Dybvig (1983), all depositors' savings are intermediated as financial intermediaries are able to provide their depositors with insurance against idiosyncratic liquidity risk. Each banker j allocates her deposits into money and loans to entrepreneurs.

The final agent in this economy is a government (or central bank) that adopts a constant money growth rule. Denote the real aggregate money stock in period t by $\tilde{m}_t$. The evolution of real money balances between periods $t-1$ and t is expressed as:

$$\tilde{m}_t = \sigma \frac{P_{t-1}}{P_t} \tilde{m}_{t-1} \tag{1}$$

where $\sigma > 0$ is the constant gross rate of money creation (or destruction when $\sigma < 1$) imposed at the beginning of time. In addition, $\frac{P_{t-1}}{P_t}$ is the gross real return on money balances between period $t-1$ and t. The government uses its seigniorage income to purchase goods. Denote the total amount of goods acquired by the government at the beginning of period t by τ_t where:

$$\tau_t = \frac{\sigma - 1}{\sigma} \tilde{m}_t \tag{2}$$

As a benchmark, we follow Huybens and Smith (1999) by assuming that government purchases are not redistributed back to agents and thus do not influence their decisions.

3 Trade

3.1 A Typical Entrepreneur's Problem

At the beginning of period t, a young entrepreneur works and earns the market wage rate (w_t). As entrepreneurs only value old age consumption, all income is invested in capital formation (i_t).[4] However, we will focus on conditions in which entrepreneurs' desired investment exceeds their internal funds. That is, we focus on cases where $w_t < i_t$. Consequently, entrepreneurs seek external financing from banks. In particular, each young entrepreneur will apply for a one period loan (b_t) from a bank at a gross real interest rate R_t. Therefore, the following resource constraint must be satisfied:

$$i_t = w_t + b_t \tag{3}$$

where

$$i_t = k_{t+1} \tag{4}$$

At the beginning of period $t+1$, an old entrepreneur uses her capital stock (k_{t+1}) and hires workers (l_{t+1}) to produce consumption goods. In turn, old-age consumption is income after payments to workers and loans to banks:

[4] It is not necessary for entrepreneurs to take advantage of the risk-pooling functions of financial intermediaries since they are not subject to the same idiosyncratic risk as depositors.

$$c_{t+1}^{e} = f\left(k_{t+1}, l_{t+1}\right) - w_{t+1} l_{t+1} - R_t b_t \tag{5}$$

with $f\left(k_{t+1}, l_{t+1}\right) = A k_{t+1}^{\alpha} l_{t+1}^{1-\alpha}$. All entrepreneurs behave competitively and an entrepreneur's problem in period t is summarized as follows:

$$\underset{i_t, l_{t+1}}{Max} \frac{\left(c_{t+1}^{e}\right)^{1-\theta}}{1-\theta} \tag{6}$$

subject to $(3) - (6)$.

Perfect competition in factor markets implies that wages earn their marginal product:

$$w_{t+1} = (1-\alpha) A k_{t+1}^{\alpha} l_{t+1}^{-\alpha} \tag{7}$$

Moreover, entrepreneurs will seek to acquire funds to the point where the marginal return from the funds obtained is aligned with the marginal cost of external financing:

$$f_{k_{t+1}} = R_t \tag{8}$$

where $f_{k_{t+1}} = \partial f\left(k_{t+1}, l_{t+1}\right) / \partial k_{t+1} = \alpha A k_{t+1}^{\alpha-1} l_{t+1}^{1-\alpha}$. Using this information, an entrepreneur's consumption in $t+1$ is such that:

$$c_{t+1}^{e} = f_{k_{t+1}} w_t \tag{9}$$

Therefore, the income of entrepreneurs is heavily dependent on the return to capital in factor markets.

Using (3), (4), and (8), the inverse demand for bank loans by a single entrepreneur is:

$$R_t = \alpha A \left(b_t + w_t\right)^{\alpha-1} l_{t+1}^{1-\alpha} \tag{10}$$

where $b_t + w_t = k_{t+1}$. In addition, it is clear that as loans become more costly, entrepreneurs rely less on external financing.

Finally, in equilibrium labor market clearing requires that $L_t = \rho l_t = 1$ for all t. Substituting this information into the individual loan demand equation, (10), yields:

$$R_t = \alpha A \left[\rho \left(b_t + w_t\right)\right]^{\alpha-1} \tag{11}$$

In this manner, we have the aggregate inverse demand for loans such that $\rho\left(b_t + w_t\right) = \rho k_{t+1} = K_{t+1}$ in equilibrium. Analogously, it directly follows that the expression for wages in period t can be written as:

$$w_t = (1-\alpha) A K_t^{\alpha} \tag{12}$$

3.2 A Typical Depositor's Problem

At the beginning of period t, each depositor earns the market wage rate (w_t) which is entirely saved. Since banks are able to insure depositors against relocation shocks, all of their savings are intermediated.

4 A Typical Bank's Problem

In this economy, all bankers are identical and solve the same problem. Therefore we omit the indexation for each bank. In the deposit market, bankers compete for funds through interest rates paid on deposits. That is, at the beginning of period t, each banker announces deposit rates, taking the announced rates of return of other banks as given. A bank promises a gross real return on deposits in the amount r_t^m if a young individual is relocated and a gross real return r_t^n if not. Given that banks offer similar financial services, each bank receives the same market share in the deposit market, attracting $(1-\rho)/N$ depositors. Each bank allocates its deposits towards cash reserves and bank loans. Let m_t and b_t^s, respectively, denote the real amount of cash balances and loans supplied by each bank.

Furthermore, the loan market is characterized by Cournot (quantity) competition. That is, each bank recognizes that its own decisions about the amount of loans supplied will affect the market interest rate but its choice does not affect that of other banks. In equilibrium, price competition among banks for depositors will force them to choose return schedules and portfolio allocations to maximize the expected utility of a representative depositor. Therefore, a bank's problem is summarized as follows:

$$\underset{r_t^m, r_t^n, m_t, b_t^s}{Max} \frac{\pi \left[r_t^m w_t\right]^{1-\theta} + (1-\pi)\left[r_t^n w_t\right]^{1-\theta}}{1-\theta} \tag{13}$$

subject to the following constraints.

First, a bank's total deposits, $\frac{1}{N}(1-\rho) w_t$, are allocated towards money and loans:

$$\frac{1}{N}(1-\rho) w_t = m_t + b_t^s \tag{14}$$

In addition, payments to relocated agents of whom there are $\pi(1-\rho)\frac{1}{N}$ per financial institution are made in cash at the end of period t:

$$\pi \frac{1}{N}(1-\rho) r_t^m w_t = m_t \frac{P_t}{P_{t+1}} \tag{15}$$

Payments made to non-relocated agents are financed from the return on loans:

$$(1-\pi)\frac{1}{N}(1-\rho) r_t^n w_t = R_t b_t^s \tag{16}$$

Moreover, each bank faces the market's inverse demand for loans, (11). Finally, the contract between the banks and its depositors has to be incentive compatible:

$$r_t^n \geq r_t^m \tag{17}$$

As we demonstrate in the appendix, the solution to the problem yields the demand for money balances by a single financial institution:

$$m_t = \frac{(1-\rho)\, w_t/N}{1 + \frac{1-\pi}{\pi}\left[1 - \frac{1-\alpha}{N}\frac{K_{t+1}-\rho w_t}{K_{t+1}}\right]^{\frac{1}{\theta}} I_t^{\frac{1-\theta}{\theta}}} \tag{18}$$

where $I_t = R_t \frac{P_{t+1}}{P_t}$ is the gross nominal interest rate on loans. Alternatively, the fraction of deposits allocated towards cash balances which serves as a proxy for the degree of liquidity is:

$$\gamma_t = \frac{m_t}{(1-\rho)\, w_t/N} = \frac{1}{1 + \frac{1-\pi}{\pi}\left[1 - \frac{1-\alpha}{N}\frac{K_{t+1}-\rho w_t}{K_{t+1}}\right]^{\frac{1}{\theta}} I_t^{\frac{1-\theta}{\theta}}} \tag{19}$$

Since depositors are highly risk averse ($\theta > 1$), banks hold more liquidity when the nominal interest rate is higher. Intuitively, non-relocated depositors earn a higher return compared to relocated depositors when the return on loans is higher relative to cash. This encourages the bank to hold more cash in order to compensate its highly risk averse depositors in the bad state (when they relocate).

In addition, as banks have market power in the credit market, the term $\left[1 - \frac{1-\alpha}{N}\frac{K_{t+1}-\rho w_t}{K_{t+1}}\right] < 1$ reflects the impact of distortions in the credit market on cash holdings. Two observations are worth mentioning here. First, as the banking system becomes less competitive (lower N), banks hold a more liquid portfolio. In addition, banks allocate a larger fraction of their deposits towards cash balances under a higher level of capital investment. This takes place because imperfectly competitive banks account for the fact that interest rates need to drop to stimulate borrowing by entrepreneurs.

Upon using (14) − (16) and the expression for money demand, (18), the relative return to depositors is:

$$\frac{r_t^n}{r_t^m} = \left[1 - \left(\frac{1-\alpha}{N}\right)\frac{K_{t+1}-\rho w_t}{K_{t+1}}\right]^{\frac{1}{\theta}} I_t^{\frac{1}{\theta}} \tag{20}$$

It is clear from (20) that depositors receive less insurance against idiosyncratic shocks when the nominal return on loans is higher. In addition, for a given interest rate on loans, distortions in the credit market from market power lead to inefficiently high levels of insurance to depositors (low relative return to depositors) compared to perfect competition. This is due to the fact that banks hold more liquidity under market power. A quick inspection of (20) suggests that the nominal interest rate needs to be above a threshold level for

the incentive compatibility constraint, (17), to hold. In particular, we need: $I \geq \frac{1}{\left[1-\frac{1-\alpha}{N}\left(1-\rho\frac{1}{\Omega(K)}\right)\right]} \equiv \underline{I}$, where $\underline{I} > 1$.

Finally, the expected consumption of a depositor, which we denote as Ec_{t+1}^d is:

$$Ec_{t+1}^d = \left(\pi + (1-\pi)\frac{r_t^n}{r_t^m}\right) r_t^m w_t \tag{21}$$

4.1 General Equilibrium

We proceed to look at activity in general equilibrium. To begin, labor market clearing requires that $L_t = 1$ and the market wage rate is given by (12). Moreover, aggregate demand for loans is:

$$b_t^D = K_{t+1} - \rho w_t \tag{22}$$

where $b_t^D = \rho b_t$ and K_{t+1} is such that:

$$R_t = \alpha A K_{t+1}^{\alpha-1} \tag{23}$$

On the supply side, the banking system supplies Nb_t^s in loans to entrepreneurs. From a bank's balance sheet (14) and the money demand equation, (18), the total supply of loans is:

$$Nb_t^s = (1-\rho)\, w_t \left[1 - \frac{1}{1 + \frac{1-\pi}{\pi}\left[1 - \frac{1-\alpha}{N}\frac{K_{t+1}-\rho w_t}{K_{t+1}}\right]^{\frac{1}{\theta}} I_t^{\frac{1-\theta}{\theta}}}\right] \tag{24}$$

Obviously, credit market clearing requires:

$$Nb_t^s = b_t^D = K_{t+1} - \rho w_t \tag{25}$$

Finally, from the evolution of cash balances in (1) and real money demand by banks, (18), the money market clearing condition yields the evolution of the nominal interest rate on loans:

$$I_{t+1} = \left(\frac{\pi}{1-\pi}\right)^{\frac{\theta}{1-\theta}} \frac{\left(\left[1 + \frac{1-\pi}{\pi}\left[1 - \frac{1-\alpha}{N}\frac{K_{t+1}-\rho w_t}{K_{t+1}}\right]^{\frac{1}{\theta}} I_t^{\frac{1-\theta}{\theta}}\right] \frac{k_{t+1}^{\alpha}}{k_t^{\alpha}} \frac{P_{t+1}}{P_t}\frac{1}{\sigma} - 1\right)^{\frac{\theta}{1-\theta}}}{\left[1 - \frac{1-\alpha}{N}\frac{K_{t+2}-\rho w_{t+1}}{K_{t+2}}\right]^{\frac{1}{1-\theta}}} \tag{26}$$

The system of equations, (22) – (26), summarizes the behavior of the economy at a particular point in time. In addition, using (9) and (21), the expected consumption of an entrepreneur relative to that of a depositor – a proxy for income inequality – can be expressed as:

$$\frac{c_{t+1}^{e}}{Ec_{t+1}^{d}} = \frac{I_t}{\left(\pi + (1-\pi)\frac{r_t^n}{r_t^m}\right)\frac{1}{\pi}\gamma_t} \tag{27}$$

The primary focus of this manuscript is on the behavior of the economy in the steady-state which we address in the following section.

4.2 Steady-State Analysis

From (22) and (24), the credit market clearing condition given by (25) in the steady-state becomes:

$$\Omega(K) = 1 - \frac{(1-\rho)}{\left[1 + \frac{1-\pi}{\pi}\left[1 - \frac{1-\alpha}{N}\left(1 - \frac{\rho}{\Omega(K)}\right)\right]^{\frac{1}{\theta}} I^{\frac{1-\theta}{\theta}}\right]} \tag{28}$$

where $\Omega(K) = K/w$ is the capital to wage ratio with $\Omega'(K) > 0$. The polynomial, (28), represents the combinations of K and I that clear the credit market.

In addition, from the money market clearing condition, (26), the inflation rate is constant in the steady-state and is pinned down by the rate of money creation, with $\frac{P_{t+1}}{P_t} = \sigma$. Upon using (23) and the fact that $I = R\sigma$, the inverse demand for capital is given by:

$$I = \alpha A K^{\alpha-1}\sigma \tag{29}$$

The two loci above summarize the stationary behavior of the economy. We proceed to characterize (28) and (29) in the following Lemma.

Lemma 1.

a. The locus defined by (28) *satisfies the following:*
$\frac{dI}{dK} < 0$, $\lim_{I\to\infty} K \to \Omega^{-1}(\rho)$, *and* $K = \bar{K}^S$ *if* $I = \underline{I}$

b. The locus defined by (29) *satisfies the following:*
$\frac{dI}{dK} < 0$ if $I < \bar{I}$, $K = \Omega^{-1}(\rho)$ if $I \geq \bar{I}$, *where* $\bar{I} = \frac{\alpha}{(1-\alpha)}\frac{\sigma}{\rho}$, *and* $K = \bar{K}^S$ *if* $I = \underline{I} < \bar{I}$.

From our analysis of the bank's problem, banks hold more liquid portfolios under a higher interest rate to satisfy their highly risk averse depositors. This implies that the amount of loans (capital) provided to entrepreneurs is lower. In turn, the capital stock needs to fall to clear the credit market. In the limit, as the nominal interest rate is infinitely large, banks' lending must be zero and the capital stock approaches asymptotically to $\Omega^{-1}(\rho)$.

On the demand side, entrepreneurs rely less on external financing when the cost of borrowing is higher. Therefore, investment projects would be fully internally financed when the interest rate is above some level. Both loci are illustrated in Figure 2 below.

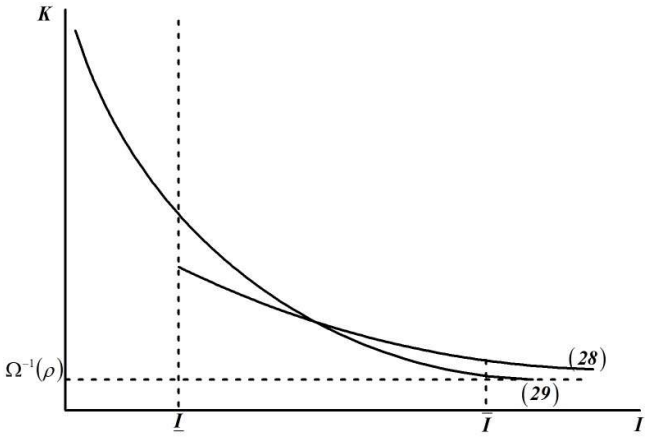


Figure 2. Steady-State Equilibrium

Proposition 1. *Suppose $\sigma > \underline{\sigma}$ where $\underline{\sigma}$ is defined in the appendix. Under this condition, a steady-state exists and is unique.*

In particular, we focus on equilibria where money is dominated in rate of return and both money and credit are held. Money is dominated in rate of return if $I > 1$. This condition necessarily holds when the incentive compatibility constraint, (20) , is satisfied since $\underline{I} > 1$. As we demonstrate in the appendix, the equilibrium nominal interest rate, I^*, exceeds $\underline{I}$ if the rate of money growth is above a certain level, $\underline{\sigma}$. In addition, we show that $I^* < \bar{I}$ for all $\sigma > 0$. Therefore, entrepreneurs seek external financing in the feasible domain. When the condition in Proposition 1 is met, an equilibrium exists and is unique.

We proceed to study the effects of banking competition on various economic outcomes.

Proposition 2. $\frac{dK}{dN} > 0$, $\frac{dI}{dN} < 0$, $\frac{d\frac{r^n}{r^m}}{dN} > 0$, *and* $\frac{d\frac{c^e}{E(c^w)}}{dN} < 0$.

The intuition behind the result in Proposition 2 is as follows. When the banking system becomes more concentrated, banks charge a higher interest rate on loans, which hinders borrowing and capital investment. In addition, as banks hold more liquid portfolios when the sector is more concentrated, they provide their depositors with better insurance against idiosyncratic shocks.

Interestingly, our model also predicts that income inequality worsens in an economy with a more concentrated banking sector. This occurs for two primary reasons. First, although capital investment is lower when the banking system is less competitive, the higher return to capital offsets this effect resulting in higher consumption for entrepreneurs. This can be seen immediately from (9), which can be written as: $c^e = (1-\alpha)\,\alpha A^2 K^{2\alpha-1}$, if $\alpha < 1/2$. In addition,

banks in a less competitive sector offer their depositors a lower relative return on their savings. In addition, wages will be lower when capital investment is lower, leading to lower expected consumption for depositors. As a result, $\frac{d\frac{c^e}{E(c^w)}}{dN} < 0 \ \forall \alpha \in (0,1)$. Therefore, stimulating financial competition can help alleviate income inequality.

In the following Proposition, we discuss the effects of monetary policy:

Proposition 3. *$\frac{dK}{d\sigma} < 0$, $\frac{dI}{d\sigma} > 0$, $\frac{d\frac{r^n}{r^m}}{d\sigma} > 0$, and $\frac{d\frac{c^e}{E(c^w)}}{d\sigma} > 0$.*

The result in Proposition 3 indicates that a reverse-Tobin effect is present in our model. Intuitively, under a higher inflation rate, banks seek to hold a more liquid portfolio to offset the effect of a lower value of money on the return to movers. This necessarily happens since depositors are highly risk averse as in Schreft and Smith (1998). Moreover, since banks provide less loans, capital investment is lower. The lower supply of credit combined with higher inflation puts upward pressure on the nominal interest rate. Furthermore, from (20), depositors receive less insurance when inflation is higher.

Finally, as we demonstrate in the appendix, the higher rate of money growth raises income inequality. Following our discussion of Proposition 2, entrepreneurs are able to consume more when the capital stock is lower. By comparison, the deposit base is lower when the rate of money creation is higher due to the reverse-Tobin effect. This effect dominates the positive effect of inflation on the expected consumption of depositors due to a higher relative return on deposits. Therefore, income inequality worsens at higher inflation rates.

We proceed to answer the following question. Do the effects of inflation on capital formation, liquidity holdings, and income inequality depend on the competitive structure of the banking system? In order to answer this question, we proceed with the following proposition.

Proposition 4. *Suppose $N < N_0$, where $N_0 : \Omega = \rho^{\frac{1}{2}}$. Under this condition, $\left|\frac{d\left(\frac{dK}{d\sigma}\right)}{dN}\right| > 0$.*

Proposition 4 provides a sufficient condition for the efficacy of monetary policy on capital formation to be increasing with the degree of banking competition. Consequently, the marginal effects of inflation on capital formation and the degree of liquidity weaken as the banking system gets more concentrated. First, higher rates of money growth lower the purchasing power of money and would leave individuals susceptible to liquidity shocks with less real income and consumption. Under perfect competition, banks would acquire more money balances to protect risk-averse depositors from the liquidity shock. However, among imperfectly competitive institutions, there are strategic considerations at work. In order to take advantage of their market power in the capital market, banks would already have excessively large holdings of money balances. Thus,

the desire among concentrated banks to acquire more money balances would be weaker. In addition, the demand for credit is also less sensitive to price changes when interest rates are initially high.

Next, will the impact of inflation on income inequality be stronger if the banking sector is more concentrated? While it is hard to get a conclusive answer analytically, we resort to numerical exercises. In particular, consider the following set of parameters: $\alpha = 0.33$, $A = 1$, $\pi = 0.6$, $\theta = 2$, and $\rho = 0.1$. In Table 1 below, we present the marginal effects of inflation on the variables of interest when the number of banks, N, is 10, 20, and 100, respectively.[5]

	N=10			N=20			N=100		
σ	dK/dσ	dγ/dσ	$d(c^e/c^w)/d\sigma$	dK/dσ	dγ/dσ	$d(c^e/c^w)/d\sigma$	dK/dσ	dγ/dσ	$d(c^e/c^w)/d\sigma$
1.00									
1.01	-0.0759	0.1535	0.0943	-0.0766	0.1543	0.0932	-0.0772	0.1549	0.0924
1.02	-0.0749	0.1518	0.0941	-0.0756	0.1526	0.0931	-0.0762	0.1532	0.0922
1.03	-0.0740	0.1501	0.0940	-0.0747	0.1510	0.0929	-0.0753	0.1516	0.0921
1.04	-0.0731	0.1485	0.0938	-0.0738	0.1494	0.0928	-0.0744	0.1500	0.0919
1.05	-0.0722	0.1469	0.0937	-0.0729	0.1478	0.0926	-0.0735	0.1484	0.0918
1.06	-0.0713	0.1454	0.0936	-0.0720	0.1462	0.0925	-0.0726	0.1468	0.0916
1.07	-0.0705	0.1438	0.0934	-0.0712	0.1447	0.0923	-0.0717	0.1453	0.0915
1.08	-0.0696	0.1423	0.0933	-0.0703	0.1432	0.0922	-0.0709	0.1438	0.0914
1.09	-0.0688	0.1409	0.0931	-0.0695	0.1417	0.0921	-0.0701	0.1423	0.0912
1.10	-0.0680	0.1394	0.0930	-0.0687	0.1402	0.0919	-0.0692	0.1409	0.0911

Table 1. Marginal Effects of Inflation and Banking Competition

According to the results from the table, the answer to the above question is unfortunately, yes. The reasons primarily extend from the desire of institutions to change their portfolios at higher degrees of concentration. In a more concentrated sector, institutions are more focused on exploiting their market power in the financial system, regardless of overall macroeconomic conditions. In turn, the twin distortions – money growth and strategic behavior in capital markets – produce even more income inequality.

5 Welfare Analysis

In this section, we examine how the welfare of different groups of agents varies with the degree of banking competition and monetary policy. We begin by studying the welfare of entrepreneurs. From (6) and (9), the steady-state utility of an entrepreneur is:

$$u^e = \frac{\left((1-\alpha)\,\alpha A^2 K^{2\alpha-1}\right)^{1-\theta}}{1-\theta} \tag{30}$$

[5] The results presented in Table 1 are robust over a large set of parameters.

It is easy to verify that $\frac{du^e}{dN} < 0$ and $\frac{du^e}{d\sigma} > 0$. Intuitively, a higher degree of banking concentration raises the return on capital investment, which raises the consumption of an entrepreneur and improves her welfare. Analogously, a higher rate of money creation hinders capital investment but raises its return. Therefore, entrepreneurs are better off under a higher inflation rate.

Furthermore, using (13) and (15), the steady-state expected utility of a depositor can be expressed as:

$$Eu^d = \frac{1}{1-\theta}\left(1 + \frac{1-\pi}{\pi}\left(\frac{r^n}{r^m}\right)^{1-\theta}\right)\pi^{\theta}\left[\frac{\gamma}{\sigma}\right]^{1-\theta} w^{1-\theta} \tag{31}$$

A quick inspection of (31) suggests that changes in the competitive structure of the banking system affect the welfare of depositors in a number of ways. First, as the banking system gets more concentrated, banks pay their depositors a lower relative return (better insurance). In turn, the capital stock and wages are lower when the banking system gets more concentrated, which adversely affects the welfare of depositors. However, since banks in a concentrated system hold more liquid portfolios (higher γ), this partially offsets the negative impact of concentration on the consumption of movers. While we were not able to get a conclusive answer analytically, numerical work presented in Tables 2-4 below suggests that depositors are worse off in a more concentrated banking system.[6]

The impact of inflation on the welfare of depositors follows a similar logic. First, due to the reverse-Tobin effect, depositors earn lower wages and obtain lower welfare under higher inflation rates. However, since the real return on loans is higher, depositors earn a higher relative return, which improves their welfare. Finally, a lower value of money directly lowers the consumption of movers and welfare. Yet, overall, our numerical results indicate that inflation adversely affects the welfare of depositors.

In sum, higher degrees of banking concentration raise the welfare of entrepreneurs but lower that of depositors. Consequently, the net impact on total welfare depends on the size of each population. The expression of total welfare is such that:

$$W = \rho u^e + (1-\rho)\, Eu^d \tag{32}$$

In the examples provided in Tables 2 and 3, only 10% of the population are entrepreneurs. The results in Table 2 show that inflation is detrimental for total welfare.

By comparison, Table 3 provides examples to look at the impact of banking competition on total welfare in the economy. As can be observed, movements towards increasing competition in the banking sector lead to higher aggregate welfare. By comparison, if entrepreneurs account for 20% of the population, as in the example in Table 4, promoting banking competition lowers total welfare. As the number of entrepreneurs is higher, more capital will be invested in the

[6] All the parameters are identical to those in previous examples, except for the ones mentioned in the table.

economy and the return from capital is lower. If the banking sector is more competitive, banks don't take advantage of market power and aggregate income from capital earnings will decline. Consequently, more concentration would be expected to raise aggregate welfare if there are more "wealthy" capital owners in the economy.

ρ	0.1		
N	10		
σ	Total u^e	Total Eu^d	Welfare
1.00	-0.2442	-2.3440	-2.5881
1.01	-0.2438	-2.3591	-2.6029
1.02	-0.2434	-2.3742	-2.6176
1.03	-0.2430	-2.3893	-2.6324
1.04	-0.2426	-2.4045	-2.6471
1.05	-0.2423	-2.4196	-2.6618
1.06	-0.2419	-2.4347	-2.6766
1.07	-0.2415	-2.4498	-2.6913
1.08	-0.2412	-2.4649	-2.7061
1.09	-0.2408	-2.4800	-2.7208
1.10	-0.2405	-2.4951	-2.7356

Table 2. Monetary Policy and Welfare

ρ	0.1		
σ	1.05		
N	Total u^e	Total Eu^d	Welfare
10	-0.24226	-2.41957	-2.66184
20	-0.24331	-2.41696	-2.66027
30	-0.24366	-2.41616	-2.65981
40	-0.24383	-2.41577	-2.65959
50	-0.24393	-2.41554	-2.65946
60	-0.24400	-2.41538	-2.65938
70	-0.24405	-2.41527	-2.65932
80	-0.24408	-2.41519	-2.65928
90	-0.24411	-2.41513	-2.65924
100	-0.24413	-2.41508	-2.65921

Table 3. Banking Competition and Welfare

ρ	0.2		
σ	1.1		
N	Total u[c]	Total Eu[d]	Welfare
10	-0.52471	-2.17628	-2.70098
20	-0.52598	-2.17507	-2.70106
30	-0.52641	-2.1747	-2.70111
40	-0.52661	-2.17452	-2.70114
50	-0.52674	-2.17442	-2.70116
60	-0.52682	-2.17435	-2.70117
70	-0.52688	-2.1743	-2.70118
80	-0.52693	-2.17426	-2.70119
90	-0.52696	-2.17423	-2.70119
100	-0.52699	-2.17421	-2.7012

Table 4. Welfare Under a Higher Population of Entrepreneurs

6 Empirical Results

We now seek to describe the empirical analysis which will be used to test the main predictions of our model. Notably, there are a number of important predictions from the framework. The first is that concentration ratios affect liquidity holdings among banks. In particular, the model demonstrates that the impact of money growth on cash reserves is weaker in more concentrated banking sectors. Consequently, the framework predicts that capital formation will be lower if there is less competition and that the effects of money growth on capital accumulation also depend on the degree of concentration.

In addition, economies with greater concentration are also associated with greater income inequality. That is, greater concentration of assets in banking systems will lead to a higher concentration of income across populations. Moreover, the adverse effects of money growth on income inequality are magnified under higher concentration ratios. In other words, income inequality is worse under the twin distortions of higher money growth rates and banking concentration.

We begin by describing the data that we study. Table 5 presents summary statistics for all variables in our sample. First, as a measure of income inequality, we concentrate on using the *GINI* coefficient which is available from the World Development Indicators of the World Bank. The data is available for an average of around 125 different countries.[7] However, the number of observations varies over time in the sample.

We next discuss the primary control variables. As economic growth has been shown to be an important factor in the extent of income inequality, we include *GDP-Growth* as an important control variable. We also include the growth rate of M1, *M1-Growth*, as an indicator of the stance of monetary policy. This variable is obtained from the first difference of the money supply in log levels.[8]

[7] Source Code: SI.POV.GINI. Accessed March 2015.
[8] Source Code: FM.LBL.MONY.CN.

The concentration ratio (CR) is of particular interest for our work. The data we utilize comes from the World Bank Global Financial Database, but it is derived from Bankscope. The variable provides evidence on the three-firm concentration ratio across countries over time. The earliest that the data appears for any country is 1998 but its availability varies across countries and time.

We also describe the other dependent variables that we study. As we mentioned, the model makes predictions regarding the impact of concentration on cash reserves held by banks. In order to examine this prediction empirically, we study the ratio of bank liquid reserves to bank assets ($LRBA$) obtained from the World Development Indicators of the World Bank.[9] The measure summarizes the amount of domestic currency along with deposits at monetary authorities relative to assets of banks in a country in a year. In addition, we look at the role of concentration and money growth for capital formation. To do so, we analyze the amount of gross capital formation as a percentage of GDP (*Capital Stock*).

Our initial task is to study the impact of money growth and the concentration ratio for the holdings of cash reserves across the banking system. The results begin in Table 6A. We first present results concerning the role of money growth. For example, the model predicts that higher rates of money growth will be associated with increased liquidity among banks. Column (I) presents the results in the absence of country or year fixed-effects. Each control variable has its expected sign and the coefficient estimate for money growth is statistically significant beyond the 1% level. After accounting for country-specific unobservables as shown in column (II), the coefficient estimates for money and GDP-growth both fall though they remain statistically significant at conventional levels. Column (III) shows that upon including year fixed effects, only the coefficient estimate for money growth remains significant.

We turn to the role of banking concentration. By itself, the concentration ratio does not appear to be a strong determinant of cash reserves. Only the coefficient estimate in column (VI) is statistically significant but it has the wrong sign. Instead, Table 6B examines if the impact of money growth depends on the extent of concentration. To do so, we include the CR as an interactive term along with the money growth rate. Here the results match up with the predictions of the model. The coefficient on the interactive term is negative and statistically significant after controls for country-specific unobservables (as shown in column II) and both country and year fixed effects (column III).

We briefly summarize how the empirical results stand relative to the predictions of the model. First, as predicted, higher rates of money growth are positively correlated with the amount of cash reserves held by banks. And, second, the effects of money growth on bank reserves are weaker if the banking sector is more concentrated. On its own, the CR doesn't seem to matter too much.

Tables 7A and 7B examine the determinants of capital formation. The first three columns in Table 7A generally show that the rate of money growth has

[9] Source Code: FD.RES.LIQU.AS.ZS.

the expected sign as predicted by the model and that the coefficient estimate is statistically significant. Matching the predictions of the model, columns (V) and (VI) indicate economies with higher banking concentration have less capital formation. However, the results in Table 7B for the interactive term are not statistically significant. Consequently, it appears that the degree of concentration – independent of money growth – tends to interrupt capital formation.

The final set of results are shown in Table 8. First, we need to point out that there are not as many observations for the *GINI* coefficient as the other dependent variables. Thus, it is not realistic to control for *both* country-specific unobservables and year fixed effects. As expected by previous work, higher rates of GDP-growth can combat income inequality (Column I). However, the coefficient estimate is not statistically significant after including country fixed effects.

Interestingly, there is much support for the predictions of the model regarding banking concentration and income inequality. While the coefficient estimate in column (III) has the wrong sign, banking concentration has a positive coefficient after controlling for country-specific unobservables. Moreover, the evidence in column (VI) indicates that the adverse effects of money growth on income inequality are stronger if the banking sector is more concentrated. This is also consistent with the predictions from the model. Finally, both columns (IV) and (VI) indicate that the concentration ratio is the only control variable that matters if one includes country fixed effects.

7 Conclusions

Would greater concentration of assets in banking systems lead to more concentration of income across societies? We view this question to be quite relevant given the recent attention to the industrial organization of the banking system. Addressing this issue is particularly important for developing countries which tend to have more income inequality than the advanced world. In addition, it is well known that poor countries tend to have higher rates of money growth than developed countries. The combination of the two distortions would likely have serious implications for the income distribution.

To consider these important matters, we develop a monetary growth model with heterogeneous agents: capital owners and those who hold liquid assets. The model demonstrates that greater concentration in the banking system can also lead to greater concentration of income. Furthermore, the twin distortions from money growth and banking concentration reinforce each other. Finally, we present evidence based upon cross-country data to examine if the predictions from the model appear to be empirically relevant. Unfortunately, both the model and the data tell us that banking concentration would have adverse effects on income distributions across countries.

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8 Technical Appendix

1. **Proof of Proposition 1.** To begin, it is trivial to show that under a Cobb-Douglas production function, the demand for capital, (29) can be expressed as:

$$\Omega(K) = \frac{\alpha}{(1-\alpha)I}\sigma \tag{33}$$

where $\Omega(K) = K/w$ as defined in the text. Given the characterization of (28) and (29) in Lemma 1, a unique solution exists if at $\underline{I}$, $K^D > K^S$, or equivalently $\Omega\left(K^D\right) > \Omega\left(K^S\right)$. Evaluating each locus at $\underline{I} = \frac{1}{\left[1-\frac{1-\alpha}{N}\left(1-\rho\frac{1}{\Omega(K)}\right)\right]}$, it can be easily shown that:

$$\Omega\left(K^D\right) = \frac{\frac{\alpha}{1-\alpha}\left(1-\frac{1-\alpha}{N}\right)\sigma + \sqrt{\left[\frac{\alpha}{1-\alpha}\left(1-\frac{1-\alpha}{N}\right)\sigma\right]^2 + 4\rho\frac{\alpha}{N}\sigma}}{2}$$

and

$$\Omega\left(K^S\right) = \frac{-\frac{\left[\left(\rho\frac{1-\alpha}{N}-1+\frac{1-\alpha}{N}\right)\frac{1-\pi}{\pi}-\rho\right]}{\left[1+\frac{1-\pi}{\pi}\left(1-\frac{1-\alpha}{N}\right)\right]} + \sqrt{\left(\frac{\left[\left(\rho\frac{1-\alpha}{N}-1+\frac{1-\alpha}{N}\right)\frac{1-\pi}{\pi}-\rho\right]}{\left[1+\frac{1-\pi}{\pi}\left(1-\frac{1-\alpha}{N}\right)\right]}\right)^2 + 4\frac{\rho\frac{1-\pi}{\pi}\frac{1-\alpha}{N}}{\left[1+\frac{1-\pi}{\pi}\left(1-\frac{1-\alpha}{N}\right)\right]}}}{2}$$

With some simplifying algebra, $\Omega\left(K^D\right) > \Omega\left(K^S\right)$ at $\underline{I}$ if:

$$\left[1+\frac{1-\pi}{\pi}\left(1-\frac{1-\alpha}{N}\right)\right]\left[\frac{\alpha}{1-\alpha}\left(1-\frac{1-\alpha}{N}\right)\sigma - 1 + \sqrt{\left[\frac{\alpha}{1-\alpha}\left(1-\frac{1-\alpha}{N}\right)\sigma\right]^2 + 4\rho\frac{\alpha}{N}\sigma}\right] + 1 - \rho\left(1-\frac{1-\alpha}{N}\frac{1-\pi}{\pi}\right) > \sqrt{\left[\left(\rho\frac{1-\alpha}{N}-1+\frac{1-\alpha}{N}\right)\frac{1-\pi}{\pi}-\rho\right]^2 + 4\rho\frac{1-\pi}{\pi}\frac{1-\alpha}{N}\left[1+\frac{1-\pi}{\pi}\left(1-\frac{1-\alpha}{N}\right)\right]} \tag{34}$$

Given that the term on the left-hand side of (34) is strictly increasing with σ, it is trivial to show that there exists a $\underline{\sigma} > 0$ that satisfies the above with equality. For all $\sigma \geq \underline{\sigma}$, $\Omega\left(K^D\right) \geq \Omega\left(K^S\right)$. Next, we need entrepreneurs to borrow from financial markets. Therefore, in equilibrium, we need $I \leq \bar{I}$, *where* $\bar{I} = \frac{\alpha}{(1-\alpha)}\frac{\sigma}{\rho}$. This requires $\Omega\left(K^D\right) < \Omega\left(K^S\right)$ when evaluated at $\bar{I}$. From the work in the text, $\Omega\left(K^D\right) = \rho$ at $\bar{I}$. In addition, it is trivial to show that the capital supply is such that:

$$\Gamma\left(K^S\right) \equiv \Omega\left(K^S\right) + \frac{(1-\rho)}{\left[1+\frac{1-\pi}{\pi}\left[1-\frac{1-\alpha}{N}\left(1-\frac{\rho}{\Omega(K^S)}\right)\right]^{\frac{1}{\theta}}\left(\frac{\alpha}{(1-\alpha)}\frac{\sigma}{\rho}\right)^{\frac{1-\theta}{\theta}}\right]} = 1 \tag{35}$$

which has a unique value $\Omega\left(\underline{K}^S\right)$. Therefore, $\Omega\left(\underline{K}^S\right) > \rho$ if $\Gamma\left(\Omega^{-1}(\rho)\right) < 1$. Upon using (35) and some simplification, $\Gamma\left(\Omega^{-1}(\rho)\right) < 1$ if:

$$0 < \frac{1-\pi}{\pi}\left(\frac{\alpha}{(1-\alpha)}\frac{\sigma}{\rho}\right)^{\frac{1-\theta}{\theta}}$$

which always holds for $\sigma > 0$. The result in Proposition 1 directly follows. This completes the proof of Proposition 1.

2. **Proof of Proposition 2.** The impact of changes in N on K and I can be easily observed from (28). It is trivial to show that the supply of capital shifts leftward under higher values of N. A simple inspection of Figure 2 above, implies that $\frac{dK}{dN} > 0$ and $\frac{dI}{dN} < 0$. We proceed to examine how the degree of banking competition affects risk sharing and income inequality. We begin by re-writing (20) in the following manner. First, from (14) we have:

$$1 - \Omega(K) = \frac{Nm}{w} \tag{36}$$

Furthermore, using (12) and (29) into (18), it is easily verified that:

$$\frac{Nm}{w} = \frac{\left(1 - \frac{\rho}{\Omega(K)}\right)\sigma}{\frac{(1-\alpha)}{\alpha}\frac{1-\pi}{\pi}\left[1 - \left(\frac{1-\alpha}{N}\right)\left(1 - \frac{\rho}{\Omega(K)}\right)\right]^{\frac{1}{\theta}} I^{\frac{1}{\theta}}} \tag{37}$$

From (36) and (37), we have:

$$\left[1 - \left(\frac{1-\alpha}{N}\right)\left(1 - \frac{\rho}{\Omega(K)}\right)\right]^{\frac{1}{\theta}} I^{\frac{1}{\theta}} = \frac{\left(1 - \frac{\rho}{\Omega(K)}\right)\sigma}{\frac{(1-\alpha)}{\alpha}\frac{1-\pi}{\pi}(1 - \Omega(K))} \tag{38}$$

Upon using (38) into (20) we get:

$$\frac{r^n}{r^m} = \frac{\left(1 - \frac{\rho}{\Omega(K)}\right)\sigma}{\frac{(1-\alpha)}{\alpha}\frac{1-\pi}{\pi}(1 - \Omega(K))} \tag{39}$$

Given that $\Omega'(K) > 0$ and $\frac{dK}{dN} > 0$, it directly follows that $\frac{d\frac{r^n}{r^m}}{dN} > 0$.

With respect to income inequality, we start by deriving (27). From (9) in the steady-state, $c^e = Rw$ and $Ec^d = \pi r^m w + (1-\pi) r^n w$. Therefore:

$$\frac{c^e}{Ec^d} = \frac{R}{\left(\pi + (1-\pi)\frac{r^n}{r^m}\right) r^m} \tag{40}$$

Upon using (15) and (16) into (40) and some algebra, we get the expression in the text:

$$\frac{c^e}{Ec^d} = \frac{I}{\left(\pi + (1-\pi)\frac{r^n}{r^m}\right)\frac{1}{\pi}\gamma}$$

Alternatively,

$$\frac{\rho}{1-\rho}\frac{c^e}{E\left(c^w\right)} = \frac{\rho R w}{N\frac{m}{\sigma} + NRb^s} \tag{41}$$

Using the fact that $Nb^s = (1-\rho)\,w - Nm = K - \rho w$ and $I = R\sigma$ into (41) with some simplification, we get:

$$\frac{c^e}{E\left(c^w\right)} = \frac{1-\rho}{\frac{1}{I} + \left(1-\frac{1}{I}\right)\Omega\left(K\right) - \rho}$$

Moreover, upon substituting for Ω from (33) we obtain:

$$\frac{c^e}{E\left(c^w\right)} = \frac{1-\rho}{\frac{1}{I}\left(1 + \left(1-\frac{1}{I}\right)\frac{\alpha}{(1-\alpha)}\sigma\right) - \rho} \tag{42}$$

Define the term in the denominator of (42) by D, with:

$$D = \frac{1}{I}\left(1 + \left(1-\frac{1}{I}\right)\frac{\alpha}{(1-\alpha)}\sigma\right) - \rho$$

If $\frac{\partial D}{\partial I} < 0$, then $\frac{d\frac{c^e}{E(c^w)}}{dN} < 0$, since $\frac{dI}{dN} < 0$. Differentiating D with respect to I yields:

$$\frac{\partial D}{\partial I} = -\frac{1}{I^2}\left(1 + \left(1-\frac{1}{I}\right)\frac{\alpha}{(1-\alpha)}\sigma\right) + \frac{1}{I_t}\frac{1}{I^2}\frac{\alpha}{(1-\alpha)}\sigma$$

$\frac{\partial D}{\partial I} < 0$ if:

$$I > \frac{2}{\frac{1-\alpha}{\alpha}\frac{1}{\sigma} + 1}$$

Upon using (33), this condition can be written as:

$$\frac{1}{\Omega} + I > 2$$

which always holds given that $\Omega < 1$ and that $I >> 1$. Therefore, $\frac{d\frac{c^e}{E(c^w)}}{dN} < 0$ across the feasible domain. This completes the proof of Proposition 2.

3. **Proof of Proposition 3.** The impact of changes in σ on K and I can be easily observed from (29). It is trivial to show that the demand of capital shifts rightward under higher values of σ. A simple inspection of Figure 2 above implies that $\frac{dK}{d\sigma} < 0$ and $\frac{dI}{d\sigma} > 0$. Given this information, it is trivial to see from (20) that $\frac{d\frac{r^n}{r^m}}{d\sigma} > 0$. Finally, we examine the effects of monetary policy on income inequality. With simple algebra, (41) can be written as:

$$\frac{\rho}{1-\rho}\frac{c^e}{E\left(c^w\right)} = \frac{\rho w}{N\frac{m}{I} + Nb^s} \tag{43}$$

where $Nb^s = (1-\rho)\,w - Nm = K - \rho w$ and

$$N\frac{m}{I}=\frac{(1-\rho)\,w}{\left[1+\frac{1-\pi}{\pi}\left[1-\frac{1-\alpha}{N}\left(1-\frac{\rho}{\Omega}\right)\right]^{\frac{1}{\theta}}I^{\frac{1-\theta}{\theta}}\right]I}$$

Using this information into (43) with some algebra:

$$\frac{c^e}{E\left(c^w\right)}=\frac{1-\rho}{\frac{(1-\rho)}{I+\frac{1-\pi}{\pi}\left[1-\left(\frac{1-\alpha}{N}\right)\left(1-\frac{\rho}{\Omega(K)}\right)\right]^{\frac{1}{\theta}}I^{\frac{1}{\theta}}}+\Omega\left(K\right)-\rho}$$

Given the effects of inflation on K and I, it directly follows that $\frac{d\frac{c^e}{E(c^w)}}{d\sigma}>0$. This completes the proof of Proposition 3.

4. **Proof of Proposition 4.** Upon using (28) and (29), the equilibrium amount of capital solves the following polynomial:

$$\Omega\left(K\right)=1-\frac{\left(1-\frac{\rho}{\Omega(K)}\right)\sigma^{\frac{\theta-1}{\theta}}K^{\frac{1-\alpha}{\theta}}}{\left[\alpha A\right]^{\frac{1}{\theta}}\frac{(1-\alpha)}{\alpha}\frac{1-\pi}{\pi}\left[1-\left(\frac{1-\alpha}{N}\right)\left(1-\frac{\rho}{\Omega(K)}\right)\right]^{\frac{1}{\theta}}} \tag{44}$$

Upon differentiating (44) with respect to σ and some algebra we get

$$\frac{dK}{d\sigma}=\frac{-\frac{\theta-1}{\theta}\frac{1}{(1-\alpha)}K}{\sigma\left[\frac{\Omega}{1-\Omega}+\frac{1}{\frac{\Omega}{\rho}-1}+\frac{1}{\theta}\left(1+\frac{1}{\left[\left(\frac{N}{1-\alpha}-1\right)\frac{\Omega}{\rho}+1\right]}\right)\right]} \tag{45}$$

It is clear that the term in the numerator is increasing in $N(K)$. Furthermore, the term $\left(1+\frac{1}{\left[\left(\frac{N}{1-\alpha}-1\right)\frac{\Omega}{\rho}+1\right]}\right)$ is decreasing in N. Therefore, it suffices to show that $Z\left(K\right)\equiv\frac{\Omega(K)}{1-\Omega(K)}+\frac{1}{\frac{\Omega(K)}{\rho}-1}$ is decreasing in $K\left(N\right)$. It is easily verified that $Z'<0$ if:

$$\Omega^2<\rho \tag{46}$$

Therefore, define $N_0:\Omega=\rho^{\frac{1}{2}}$. Since $\Omega'\left(K\right)>0$ for all $N<N_0$, $Z'<0$ and $\left|\frac{d\left(\frac{dK}{d\sigma}\right)}{dN}\right|>0$. This completes the proof of Proposition 4.

Table 5: Summary Statistics

	Mean	Min.	Max.	S.D.	Obs.
1. ΔGDP	.041	-.198	.296	.044	1,110
2. ΔM1	.159	-.570	1.23	.159	1,110
3. LRBA	17.4	.027	188.9	18.8	1,110
4. CR	70.8	21.8	100	19.4	1,110
5. Capital Stock	22.8	.293	62.5	6.73	1,777
6. GINI	41.6	24.2	67.4	9.66	505

Notes: Summary statistics for ΔGDP, ΔM1, LRBA, and CR match data from columns (IV) - (VI) of Table 6A and Table 6B. Numbers for Capital Stock come from columns (IV) - (VI) of Table 7A and Table 7B. GINI represents data used in Table 8.

Table 6A: Determinants of Liquidity Ratios Across Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)
ΔGDP	54.8*** (12.2)	18.2* (10.0)	2.57 (10.1)	36.6*** (12.2)	3.43 (6.11)	1.74 (7.26)
ΔM	13.8*** (.052)	4.75** (1.98)	6.84*** (1.80)	16.1*** (3.79)	5.34** (1.88)	6.40*** (1.92)
CR				.019 (.028)	-.033 (.028)	-.028* (.029)
Constant	14.9*** (.751)	34.9*** (8.05)	44.1*** (8.21)	12.0*** (1.94)	38.7*** (7.96)	42.3*** (8.30)
R-squared	.034	.763	.807	.032	.842	.843
Country FE?	No	Yes	Yes	No	Yes	Yes
Year FE?	No	No	Yes	No	No	Yes
Obs.	1,469	1,469	1,469	1,110	1,110	1,110

Notes: Heteroskedasticity-consistent standard errors are reported in parentheses below each coefficient estimate. *** denotes significance at the 1% level; ** at the 5% level; and * at the 10% level.

Table 6B: Determinants of Liquidity Ratios Across Countries

	(I)	(II)	(III)
ΔGDP	36.6*** (12.3)	1.88 (6.28)	.538 (7.37)
ΔM	15.5 (9.71)	17.3** (7.35)	17.9** (7.25)
CR*M1	$9.12*10^{-3}$ (.133)	-.157* (.087)	-.150* (.087)
Constant	13.4*** (.748)	36.5*** (7.83)	40.3*** (8.06)
R-squared	.032	.842	.844
Country FE?	No	Yes	Yes
Year FE?	No	No	Yes
Obs.	1,110	1,110	1,110

Notes: Heteroskedasticity-consistent standard errors are reported in parentheses below each coefficient estimate. *** denotes significance at the 1% level; ** at the 5% level; and * at the 10% level.

Table 7A: Determinants of Capital Formation Across Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)
ΔGDP	2.04*** (.735)	.885*** (.555)	.786 (.521)	44.6*** (5.48)	32.6*** (3.64)	30.8*** (4.01)
ΔM	-.101* (.174)	-.078 (.130)	-.300* (.176)	-3.90*** (1.04)	-2.99*** (.858)	-2.16*** (.797)
CR				-.010 (.008)	-.062*** (.011)	-.042*** (.011)
Constant	22.5*** (.121)	18.1*** (506)	12.9*** (2.30)	22.3*** (.610)	20.5*** (1.39)	18.1*** (1.31)
R-squared	.003	.486	.518	.076	.630	.663
Country FE?	No	Yes	Yes	No	Yes	Yes
Year FE?	No	No	Yes	No	No	Yes
Obs.	5,488	5,488	5,488	1,777	1,777	1,777

Notes: Heteroskedasticity-consistent standard errors are reported in parentheses below each coefficient estimate. *** denotes significance at the 1% level; ** at the 5% level; and * at the 10% level.

Table 7B: Determinants of Capital Formation Across Countries

	(I)	(II)	(III)
ΔGDP	44.8*** (5.49)	32.3*** (3.74)	30.7*** (4.09)
ΔM	-4.90 (3.02)	.679 (2.66)	-.571 (2.63)
CR*ΔM	.013 (.039)	-.054 (.036)	-.024 (.035)
Constant	21.6*** (.247)	15.9*** (1.03)	14.8*** (.934)
R-squared	.076	.624	.660
Country FE?	No	Yes	Yes
Year FE?	No	No	Yes
Obs.	1,777	1,777	1,777

Notes: Heteroskedasticity-consistent standard errors are reported in parentheses below each coefficient estimate. *** denotes significance at the 1% level; ** at the 5% level; and * at the 10% level.

Table 8: Determinants of Income Inequality Across Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)
ΔGDP	-16.8*** (8.26)	-1.54 (2.99)	-25.2** (10.3)	-1.71 (3.13)	-27.3*** (10.2)	-1.38 (3.25)
ΔM	1.73 (1.54)	-.047 (.509)	-5.04** (2.26)	.325 (.762)	18.4*** (5.49)	-3.46 (2.41)
CR			-.100*** (.021)	.024* (.013)		
CR*M1					-.341*** (.074)	.057* (.030)
Constant	42.8*** (.594)	27.8*** (.176)	50.2*** (1.56)	26.1*** (.897)	43.6*** (.778)	27.7*** (.204)
R-squared	.009	.903	.066	.948	.058	.948
Country FE?	No	Yes	No	Yes	No	Yes
Year FE?	No	No	No	No	No	No
Obs.	800	800	505	505	505	505

Notes: Heteroskedasticity-consistent standard errors are reported in parentheses below each coefficient estimate. *** denotes significance at the 1% level; ** at the 5% level; and * at the 10% level.